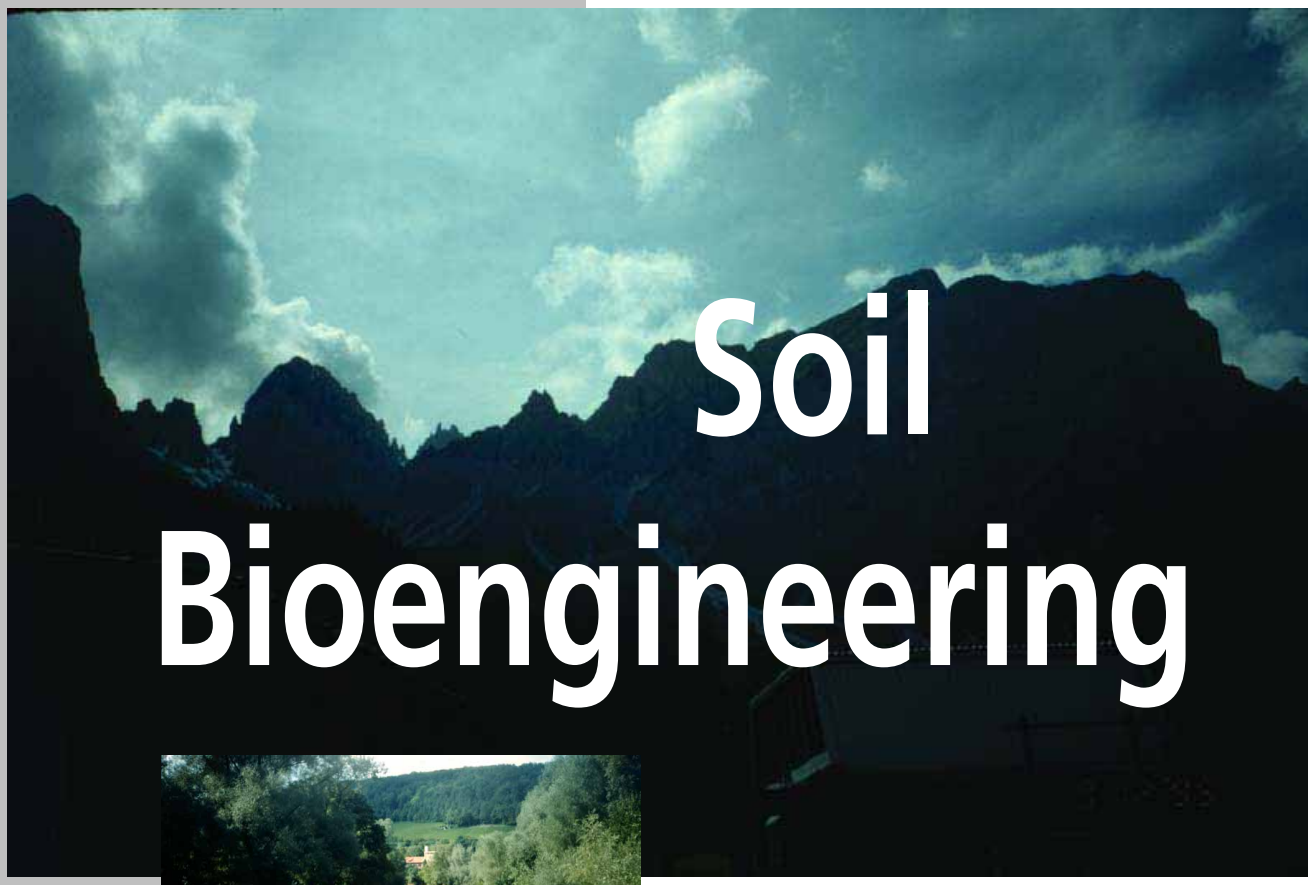

Soil Bioengineering

Technical Exchange

Switzerland, Austria, Italy

SOIL BIOENGINEERING
SCIENTIFIC AND TECHNICAL EXCHANGE

SWITZERLAND, AUSTRIA, ITALY
SEPTEMBER 4 - 15, 1995

USDA, Natural Resources Conservation Service (NRCS)

I. BACKGROUND

Switzerland, Austria, and Italy represent a community of European countries which share a long history of experience with soil bioengineering and biotechnical systems. They are actively involved in the restoration of degraded ecosystems utilizing these technologies. The exchange provided an opportunity to visit restoration sites in all three countries and to observe the technical and social aspects of using these restoration technologies. Earlier technical exchange trips to Germany , Poland and The Netherlands (1992 and 1994) provided an opportunity to make similar observations in those countries

Meanwhile, restoration work in the United States is a major focal point for the natural resources conservation community and is gaining increased popularity with a more aware society. A professional association, the Society for Ecological Restoration, has experienced extraordinary growth in its discipline diverse membership since forming less than a decade ago. It has become apparent that restoration technology offers additional alternatives in addressing many of the environmental problems faced around the globe. The demand for restoration is likely to continue to grow and the business of restoration likely to become an even greater enterprise in this country and elsewhere.

Soil bioengineering and biotechnical systems combine mechanical, biological, and ecological concepts to restore and protect streambanks, shorelines, riparian zones and associated uplands. Often the restoration technologies of choice, they offer measures that restore physical, chemical and biological functions and values; are self-sustaining; and provide opportunities to connect fragmented riparian and other landscape elements. With this in mind, the NRCS has published Chapter 18 of the National Engineering Handbook, entitled Soil Bioengineering for Upland Slope Protection and Erosion Control and Chapter 16, entitled Streambank and Shoreline Protection. Both reflect an integration of the soil bioengineering and biotechnical systems. In addition, fifteen federal agencies will cooperatively publish a document entitled *Stream Corridor Restoration: Principles, Processes, and Practices* in 1998, which will emphasize least intrusive solutions that are ecologically derived and self-sustaining.

II. PURPOSE OF TRIP

The purpose was to conduct a joint scientific and technical exchange focusing on soil bioengineering and biotechnical systems applied to streambanks, shorelines, riparian corridors and associated uplands to restore and protect ecological system functions and values. The following focus areas influenced the final trip itinerary:

• Stream and riparian corridor restoration work in context of a landscape, watershed or riverine system.

• Exposure to both rural and urban or suburban settings.

• Technology applications in diverse ecological settings.

• Use of fluvial geomorphology as a scientific basis for decision-making in stream restoration work.

• Working arrangements with and details regarding the Institute for Biological Engineering centered in Vienna, Austria.

• Effects of recent flooding events in Europe on installed systems, and lessons learned.

III. SPECIFIC OBJECTIVES

• Gather knowledge and information for adaptation to similar situations in the U.S.

• Exchange technical information and materials relating to soil bioengineering stabilization techniques.

• Explore potential of establishing international agreements regarding research, development, and transfer of restoration technologies such as soil bioengineering.

• Identify emerging issues and needs related to soil bioengineering and restoration activities in countries visited, which may provide a glimpse of our future in the United States.

• Policies of visited countries regarding use of native plant species as contrasted to released cultivars and subsequent success of native plants.

• Determine policies of visited countries regarding use of native plant species as contrasted to released cultivars and subsequent success of native plants.

• Determine interest in short and long term exchanges of personnel at expense of assigning countries for the purpose of technology exchange.

• Determine potential for cooperative international symposia focusing on restoration technologies such as soil bioengineering.

• Identify key documents, handbooks, reports, and case studies that can be published in several languages.

• Establish and develop contacts and relationships for future exchanges.

NRCS team members in Austria, l to r: Ron Tuttle, Dave Burgdorf and Jerry Bernard

IV. PARTICIPANTS

The people in the following lists participated at various field observation stops. A high degree of synergy was achieved through the mix of people from the USDA-NRCS, a U.S. consulting firm (Robbin Sotir and Associates, Marietta, GA), a U.K. consulting firm (Geostructures Consulting, Edenbridge, Kent), Marco Subic (BIOTEC Consulting) and Joze Papez of Slovenia, and a rich mix of local practitioners, government officials, and world-renowned experts in Switzerland, Austria, and Italy. Jerry Bernard, David Burgdorf, and Ron Tuttle participated at all of the stops listed in Appendix A. Robbin Sotir and Alton Simms were at all of the Switzerland and Austrian stops, while David Barker, Marco Subic and Joze Papez participated in part of the Swiss, Austrian and Italian locations. The mission's success is attributed to the European coordinator, Beatus (pronounced bay-o-tus), or Beat (pronounced *bay-ot*), Scheuter of Belp, Switzerland. He arranged all of the local contacts and itinerary, and who, in spite of significant logistical challenges, led the group efficiently through the history, inspection, evaluation, and discussion of numerous sites involving resource protection via soil bioengineering and geotechnical engineering practices. Credit also goes to each of the local practitioners, government officials and participating experts who so graciously shared their experience and knowledge with us. The good will and hospitality extended by our hosts was sincerely appreciated by the team members and associates.

Team in Switzerland, l to r: Jerry Bernard, Alton Simms, Robbin Sotir, Beatus Scheuter, Dave Burgdorf and Ron Tuttle

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V. ITINERARY

Jerry Bernard, David Burgdorf, and Ron Tuttle met host Beatus Scheuter and consultants, Robbin Sotir and Alton Simms on September 3, 1995. Objectives of the technical exchange were reviewed, as well as specific soil bioengineering work to be reviewed during the two-week exchange trip. All in-country travel was via an eight-passenger rental van.

Detailed summary of observations and characteristics for each site is found in Appendix A.

Switzerland

Austria

Italy

SUMMARY OF SITES

SWITZERLAND

Dates	Site #	Site Description
9/4/95	1	Railroad cut slope stabilization and revegetation with soil bioengineering practices
9/4/95	2	Stabilization and revegetation of very steep cut slope along pedestrian greenbelt walkway near school and commercial center in small community.
9/4/95	3	River diversion with groins and soil bioengineering on large river
9/4/95	4	Meeting with Switzerland's federal water management agency
9/5/95	5	Thur River -- Large river stabilization and wetland restoration
9/5/95	6	Thur River -- Large river stabilization and wetland restoration
9/5/95	7	Thur River -- Large river stabilization and wetland restoration
9/5/95	8	Thur River -- Large river stabilization and wetland restoration
9/5/95	9	Wetland creation and stream restoration along with new highway construction
9/5/95	10	Erosion control on steep hillside vineyard
9/5/95	11	Forestland and gravel pit reclamation
9/5/95	12	Ecologically focused sod farm practices
9/5/95	13	Samen AG, Seed company that specializes in native seeds
9/5/95	14	Brick plant slope reclamation, hydroseeding
9/5/95	15	Stream stabilized and functions restored by local community citizens
9/6/95	16	Highway cut slope stabilization using geogrids
9/6/95	17	Slope stabilization and revegetation adjacent to new rail alignment
9/6/95	18	Noise abatement wall, slope protection through revegetation and geotechnical stability solutions adjacent to rairoad and highway
9/6/95	19	Noise abatement wall along highway installed for adjacent community and landscape ecology
9/6/95	20	Birs River restoration for salmon habitat, using volunteer labor
9/6/95	21	Restoration of small stream near community cemetery
9/7/95	22	Lake Zug beach stabilization
9/7/95	23	Lake Zug beach stabilization
9/7/95	24	Slope stabilization along Incline Railway and revegetation of clear-cut mountain slope
9/7/95	25	Large Sewage Treatment Plant (STP) steep cut slope stabilization and revegetation
9/7/95	26	A brief glimpse of a working Swiss farm (Fritz Shar)
9/8/95	27	Vegetated geogrid sound barrier along highway to protect a farmstead
9/8/95	28	Shoreline protection using floating fascines near Lake of Bichle Marina and channel
9/8/95	29	High alphine road and slope stabilization near old military railway, tunnel, and building
9/9/95	30	Dampfbahn Steam Train cog railway (railbed and slope stabilization and protection)

AUSTRIA

Dates	Site #	Site Description
9/11/96	31	Extensive geotechnical slope stabilization system on highway roadcut associated with tunnel entrance
9/11/96	32	River diversion with central groins and vegetated boulder retaining walls
9/11/96	33	Massive concrete cribwall system with face plantings situated on very steep highway cut to create overlook
9/11/96	34	Steep high alpine slope (associated with rock fill dam) stabilization through grass/ herb revegetation
9/11/96	35	Turbid lake and wetland associated with hydroelectric operation
9/11/96	36	Selected placed stone armoring and riparian vegetation to protect banks of hydroelectric outlet channel at railroad bridge
9/12/96	37	Vegetated concrete grade control structure and stormwater collection basin
9/12/96	38	Vertical-walled concrete outlet channel softened by adjacent vegetative plantings
9/12/96	39	Watershed experiment on national forest lands to stabilize and reforest massive landslide area
9/12/96	40	Ski slope revegetation and avalanche protection
9/12/96	41	Stabilized and revegetated massive landslide area
9/12/96	42	Well established joint plantings through rock armoring to protect streambank
9/12/96	43	Fifty-year-old and well established vegetation groins to protect streambank and capture sediment for recreation beaches

ITALY

Dates	Site #	Site Description
9/13/95	44	Concrete grade control structures with vegetated log crib walls for channel stabilization and bank protection
9/13/95	45	Willow fascines and woody plantings to prevent floodplain erosion damage
9/13/95	46	Large sediment pool below series of concrete grade control structures
9/13/95	47	Cribwall stabilization on very steep slopes on State forest lands
9/13/95	48	Landslide stabilization, Rio Corno Fana

VI. TECHNICAL MATERIALS EXCHANGED

The following is a partial list of published and unpublished technical materials exchanged during the trip:

1. Diez, C. 1995. ***Bibliography Soil Bioengineering.*** Grosshøchstetten, Switzerland.

2. Federal Office for Water Management. 1995. ***Demands on flood protection***. Federal Department of Transport, Communications and Energy. Bern.

3. Frohlich, U., Niedermann, H., Weber, H. 1995. ***Implementation in the River Thur. Ingenieurbiologie NR***, 1/95, pp. 11-23 (Klaus Alt, NRCS Agricultural Economist, graciously translated this reference to integrate its potential benefits. This translation is included in Appendix A as part of the information about Site #5a).

4. Georgia Soil and Water Conservation Commission. 1994. ***Guidelines for Streambank Restoration.***

5. Goetz, A. ***Protection of Habitat Against Floods and Debris Flows in Switzerland*** (unpublished). Swiss Federal Office for Water Management.

6. Gray, D.H., and R.B. Sotir. 1995. ***Biotechnical Stabilization of Steepened Slopes***. Prepared for 74th Annual Meeting of Transportation Research Board. Washington, D.C.

7. GWA. 1993. ***Das Backkonzept der Stadt Zürich.*** Schweizerischen Vereins des Gas-und Wasserfaches (SVGW), Zürich.

8. Interagency Communication Team. 1995. ***Briefing Materials: Stream Corridor Restoration Handbook*** (unpublished). USDA, Natural Resources Conservation Service.

9. International Research Society Interpravent. ***Foundation and History***. Klagenfurt, Austria.

10. Koordinationsstelle für Umweltschutz des Kantons Zürich, 1995. ***Zürcher Umwelt Praxis***. Information's Bulletin der Umweltschultz Fachverwaltung des Kantons, Zürich.

11. Nunnally, N.R., and R.B. Sotir. 1994. ***Soil Bioengineering for Streambank Protection.*** Erosion Control, November/December 1994, pp. 39-44.

12. Oplatka, M., Diez, C., Leuzinger, Y., Palmeri, F., Dibona, L., Frossard, P., 1995. ***Dictionary of Soil Bioengineering.***

13. Sotir, R.B., 1995. ***Soil Bioengineering Experiences in North America***. Vegetation and slopes. pp. 190-201. Thomas Telford. London.

14. Sotir, R.B., and N.R. Nunnally. 1995. ***Use of Riprap in Soil Bioengineering Streambank Protection.*** John Wiley and Sons, Ltd.

15. USDA, Natural Resources Conservation Service. 1992. ***Chapter 18, Soil Bioengineering for Upland Slope Protection and Erosion Control.*** Engineering Field Handbook.

16. USDA, Natural Resources Conservation Service. 1996. ***Chapter 16, Streambank and Shoreline Protection.*** Engineering Field Handbook.

17. Zarn, B. 1993. ***Stabilization of the Riverbottom of the Emme Near Utzenstorf Via a Local Widening of the Channel.*** Wasser, Energie, Luft - eau, énergie, air. pp.67-71.

18. Zeh, H. 1993. ***Ingenieurbiologische Bauweisen***. Eidgenössisches Verkehrsund Energiewirtschaftsdepartement, Bundesamt für Wasserwirtschaft.

VII. NOTABLE RESULTS AND CONCLUSIONS

SWITZERLAND

• Long term (25 year) establishment periods are commonly prescribed for many of the soil bioengineering projects that emphasize native species, colonization, and connected corridor goals. However, establishment and maintenance funds are normally scarce for most projects.

• Commonly available materials, such as galvanized chicken wire incorporated into an overall design for slope stabilization and erosion control, are used in many innovative ways.

• Coir-wrapped soil layers were used in similar fashion to applications in the U.S. Innovations observed, however, included the use of coir-wrapped layers to facilitate slope drainage, both in horizontal and diagonal placements.

• Modeling was considered an unnecessary expense in many designs, and designers were willing to absorb a certain degree of failure in installations. Modeling activities were considered by some field practitioners to be too time consuming, too expensive, and not sensitive enough to gain useful information.

• Hosts indicated that, in many engineering projects, slope stabilization efforts were planned and designed too late to be integrated with the entire engineering design.

• Protecting villages from debris flows and avalanches are primary goals involving designs that are largely geotechnically-based with soil bioengineering support practices.

• One host/designer used the approach of first purchasing or otherwise controlling the land adjacent to a river system to be restored, and then allowing the natural river dynamics to achieve stability, with engineered structures (such as barbs and riprap) and soil bioengineering practices installed for support. This approach is similar to that used by some U.S. agencies that manage public lands, but is very difficult in Switzerland due to cost and the intense pressure to maintain private ownership of lands.

• Urban areas emphasize the planning and protection of greenbelts, greenspace, or vegetated and aesthetically pleasing areas where people travel or recreate. This is also evident in the design of new highways and railways. Highways incorporate not only bikeways or bike paths, but also bike underpasses in bridge designs. Railway designs incorporate vegetation that is natural and pleasing to people who ride the trains.

• Protection of resources from erosion and sediment, and unwanted chemicals are incorporated into all designs. Highway construction projects incorporate multistage sediment basins and constructed wetlands to trap sediment and clean runoff water of chemicals. Swiss national drinking water standard for nitrate is 40 mg/l.

• Vineyards in the Basel area near the Rhine River are planted in the direction of slope and experienced severe erosion, as late as the late 1980's. The practice was to clean till between the rows in order to eliminate weed and grass competition and to maximize production.

• Vineyards now have grape production constraints. Sod is now maintained between the rows. Vineyard production constraints: 1 kg/m^2 is current maximum grape production allowed — was up to 2 kg/m^2 for unregulated production, resulting in high nitrate levels in water due to very heavy applications of inorganic fertilizers.

• Native plants are emphasized in nearly all designs. One seed company reviewed their efforts to secure under contract adequate supplies of a very wide variety of native seeds, due to the wide variations in Swiss climate. Certification of "native" seed species remains a challenge.

• Species diversity is emphasized in designs. Native plants and weeds are allowed to colonize, as well as insects and other animal species. Green, dense vegetation continues to be considered as the "Successful" design by engineers, but the concept of long term establishment of native plants, which may be sporadic, is gaining acceptance.

• Noise barriers are commonly engineered practices along highways. Designs that incorporate soil are extremely effective in reducing noise, but droughtiness and maintenance continue to be problems. Traffic noise levels imposed on adjacent houses or villages are federally regulated and must be mitigated to standards before highway designs are approved.

• Efforts of local volunteers are applaudable, especially in terms of their long term commitment to projects.

• Several "brute force" engineering projects were reviewed, which involved the stabilization of steep cut slopes with extensive geotechnical stabilization techniques. One realizes the high value regarded by the Swiss people for their land, which is the driving force to build facilities or parks in severe locations that are not apparently economically justifiable.

• A brief visit to a working Swiss farm elicited the following observations:

  • Very diverse operations, involving feed crops, specialty crops, and livestock.

  • Long rotations are the norm, with small field sizes, managed with small equipment, and a large amount of hand labor.

  • Barn is attached to the house for heating purposes. Chickens, hogs, and dairy cows share the barn.

  • Luzern and South Colon Cantons have the most hog pollution problems relative to phosphorus pollution.

AUSTRIA

• Geotechnical engineering designs of roads and bridges and tunnels require characterizing geologic structure and performance of soil and rock materials.

• Tunneling of roads and highways is emphasized to minimize unsightly visual impacts and highway noise; also for protection from landslides and avalanches. Entrances and exits require stabilization using a variety of geotechnical techniques supported by soil bioengineering practices.

• Land is valued to such a high degree that many installations of facilities or parks do not justify the expenditure to create or stabilize them.

• Apple orchards were observed as planned elements on platforms or crowns of road tunnels or on very steep slopes. Maintenance of the trees was contracted for with local residents.

• Native seed mixtures are emphasized. Wide ranges in alpine settings require great sophistication in making seeding or planting recommendations.

• Hand-placed rock was used in a variety of conditions, most with vegetation planted in the interstices. Long term performance of the sites visited was excellent. These are examples of "hard" engineering projects that were softened with vegetation.

• The paired watershed approach is being used for research and for practical evaluation of alternatives to solve a massive landslide/debris flow problem. One watershed is allowed to try to stabilize naturally, while a variety of engineering and soil bioengineering practices are tested on the adjacent watershed. Conclusion is that the landslide area will not stabilize naturally and will continue to erode. Practices implemented in the adjacent watershed are effective in reducing the erosion.

• Austrian scientists are planning to perform research on the effect of rock size and woody vegetation on channel roughness, stability, and erosion protection. An opportunity exists for collaboration with U.S. scientists at the ARS Stillwater Hydraulics Laboratory and the ARS National Sedimentation Laboratory who are performing similar research.

ITALY

• The Süd Tirol Provincial Government is the upland erosion and torrent control organization successor to Dr. Florin Florineth, who is now Professor of Bioengineering, Institute of Biological Engineering, University of Vienna, Austria.

• Very steep stream channels require extensive use of concrete grade control structures, with some soil bioengineering support practices along the banks.

• Of special note was the successful seeding of alders, in lieu of live staking, etc. In one project, seed was propagated in Colorado, with the seedlings later returned and planted in Italy.

• Some irrigation in Switzerland and Austria, but more prevalent in the Tirol area of northern Italy on orchards and pasture, especially in Süd Tirol due to lesser rainfall in rain shadow between western and eastern slopes.

• At a meeting of state and local government officials from Italy and Austria, high praise was given to the planners and designers who, in the words of the Mayor, “saved the town” from landslides.

APPENDIX A

The following is a detailed summary of observations and characteristics for each site visited from September 4 through 15, 1995.

Site # 1

Location: Rotkreuz-Gisikon, Switzerland

Key Words: Cut slope stabilization, soil bioengineering, revegetation

Date: 9/4/95

Age: < 1 yr.

Description: A short section of wet, unstable cut slope adjacent to the SBB Railroad which was stabilized and revegetated with a combination of soil bioengineering (fascines, live stakes, & brushmattressing) and conventional engineering (riprap, drainage) systems.

Host(s): Beatus Scheuter, Dr. Roman von Sury et. al. of ANL (Ag Natur und Landschaft)

NOTES

• Cost and Area Treated: 160,000 Swiss francs and, 4,200 m^2 (32.50 Swiss francs/m^2)(excludes grading costs)

• Outlook of SBB RR is for the long term protection and enhancement of the environment along the railroad tracks. Railroad's concern, however, is that it may in fact result in too much vegetation, which would affect its efficiency and safety of operation.

• This is the only reach that the RR contracted for establishment of slope protection and long term habitat values, although the RR is stabilizing many other reaches of new cuts using more traditional methods.

• Biologists looked beyond the site, considering the larger landscape scale to determine the need for alternatives to achieve wildlife travel corridors consistent with the railroad's maintenance and operation expectations.

• Twenty-five-year time frame for achieving goals of stability and creation of desired natural habitat conditions and wildlife corridors is not considered unusual.

• Geologic consulting firm provided no expertise or recommendations for slope stabilization. Firm prepared report that consisted of all the site's limitations and real and potential hazards.

• Cut was purposely made rough and soil bioengineering techniques applied to the rough, uneven surface. Project timing and climatic conditions caused parts of the applied practices to be unsuccessful.

• Diverse site conditions required the use of both drought tolerant plants and those more suitable for generally moist conditions.

• All specified vegetation was native to the area, except for one species of willow.

• Inclusion of dead woody material in fascine to limit willow growth and to facilitate drainage.

• Inclusion of inorganic materials for surface tension (galvanized "chicken wire," galvanized reinforcement bar, screwed in reinforcement bar anchors).

• Felt weed barriers around the base of planted woody vegetation were used as drip pad along and below concrete bridge crossing over the tracks.

• Lack of control of construction activities at the job site resulted in poor results and caused the contractor (Beat) to spend more time, without cost, to execute the contract. Conditions were too dry and hot by the time the contract was let. Beat started the contract as soon as it was granted. The hot and dry conditions forced the installation to occur very quickly and involved increasing numbers of crews to complete the contract over only a four-week period.

• Job was expensive compared to more traditional methods that could have been installed, but would

not achieve the desired long term balance of habitat quality and the natural, low maintenance and lack of obstruction to the railroad's operation.

• Construction details were not up to par because of rush to complete the job due to hot weather.

• Maintenance and monitoring are part of the original contract and extend for 5 years.

Diverse site conditions required both drought and moisture tolerant plant species.

Representative view of project site.

Galvanized reinforcement barsand wire installed for surface tension

Fascines and live stakes responding well to site conditions.

Site # 2

Location: Marrgara-Burgdorf, at Burgdorf, Switzerland

Key Words: Cut slope stabilization, geotextile, soil bioengineering

Date: 9/4/95

Description: Very steep cut slope above pedestrian walkway, which connects elementary school and commercial district. Use of geotextile materials, wire and plant materials to stabilize and revegetate a highly unstable and potentially dangerous slope.

Host(s): Beat Scheuter

NOTES

• First soil bioengineering job for Beat.

• Slope stability problems, prior to Beat's work, resulted when a concrete retaining wall was broken up, and the base of the slope regraded.

• Galvanized chicken wire used from top to bottom.

• Designed placement of coir wrapped layers to facilitate both surface and subsurface water drainage.

• Aluminum straps used in construction are temporary dwelling construction material from developing countries. Innovative use of this material.

• Junipers were not suited to the site or for their position on the slope.

Coir-wrapped layers installed to facilitae both surface and subsurface drainage.

Host, Beat Scheuter, explains multiple plant species used in designed soil bioengineering system.

Aluminum straps used for added support of installed system.

Site # 3

Location: River Emme-Birne, Switzerland

Key Words: River engineering, soil bioengineering

Date: 9/4/95

Description: Conventional engineering approach used to modify river for flood control purposes. Stream dynamics not adequately addressed.

Host(s): Rudolf Mossimann

Instream modifications installed primarily for flood control.

NOTES

• Recreational use area.

• Stream is continuing to be constrained for flood control purposes without properly addressing stream dynamics.

• Rocks weirs have been installed to modify stream hydraulics.

• Stated goal of habitat enhancement for King Fisher (“Ice Bird”).

• Plans to install three additional step dams would increase the cost of the project by about 33%.

• Modeling activities used most of the money; however, it would have been cheaper to have built the weirs without any modeling.

• Excellent examples of live-staking and brushmattressing along streambank. These, however, were not part of project activities, and are likely to fail due to lateral migration of the stream channel.

Excellent response from live staking and brush mattressing installed along streambank.

Site # 4

Location: Swiss Federal Office for Water Management, Bern, Switzerland

Key Words: Water management, national planning, federal regulation

Date: 9/4/95

Description: Meeting with top management of Switzerland's Federal Water Management Agency.

Host(s): H. P. Willi, Vice-Director for Protection of Habitat Against Floods and Debris Flows in Switzerland, and A. Goetz, Section Chief for River Training.

NOTES

• Our hosts provided us with a summary of facts about Switzerland natural resources and a newly released pamphlet on flood hazard and damage reduction planning ongoing in Switzerland.

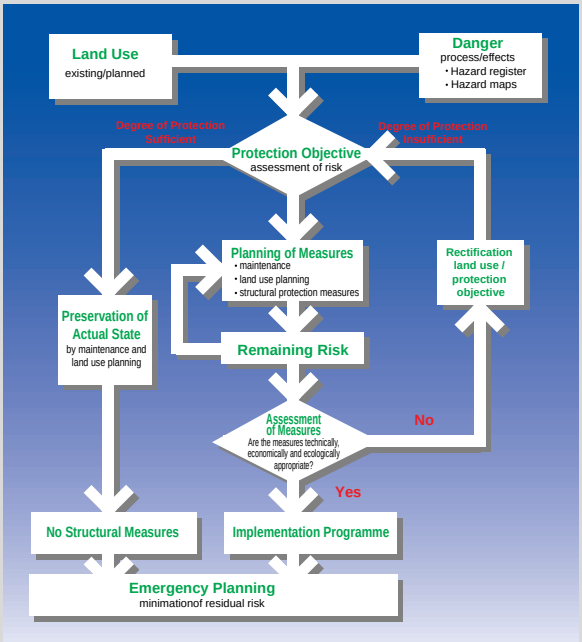
• Other sections of this Swiss Federal Agency include Legislation, Water, Water Power and Inland Navigation, Large Dams and Dam Safety, Flood Protection and Research, and Water Management.

• There are approximately 200 large dams in Switzerland.

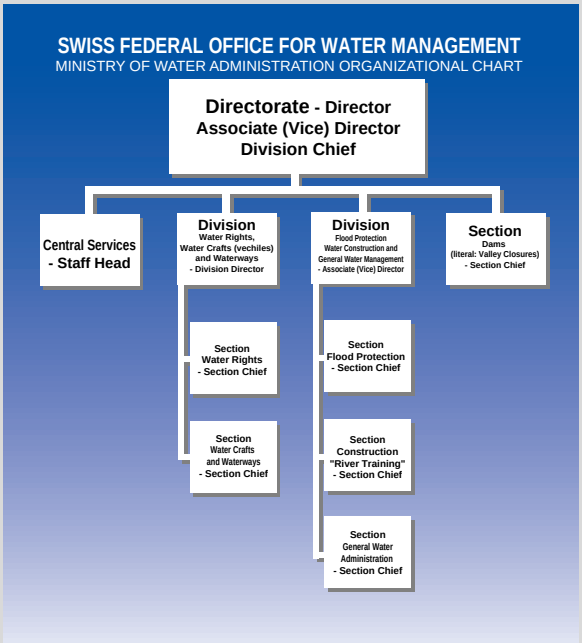
• Flood damages amount to about 200 million Swiss francs per year.

• Erosion of roads and bridges and other infrastructure are significant concerns in Switzerland .

• Debris flows are catastrophic events that impact entire villages and towns.



Swiss procedure for the planning of protection measures.



Organization of Swiss Federal Office for Water Management.

Site # 5

Location: Thur River, Switzerland

Key Words: River engineering, stream barbs, fish & wildlife habitat

Date: 9/5/95

Description: First of four stops on the Thur River to observe, at the site, booms (stream barbs) constructed on inside bend of stream. Also constructed wetland to filter runoff.

Host(s): Christian Goeldi

NOTES

• King Fisher habitat is very important objectives for any project activity.

• Putting barbs (booms) on the inside bend was useless, as recognized by Mr. Goeldi, but was done as a compromise with the design engineers.

• Drop inlets were removed to allow fish to spawn in the smaller feeder streams.

• Small constructed wetland sited near a stream to filter runoff from adjacent cropland.

Beat showing wetland constructed to filter runoff from adjacent croplands before it enters the river.

Stream barbs installed on inside bend of river will prevent them from functioning properly.

SUPPLEMENT TO THUR RIVER (Sites# 5,6,7 & 8) INGENIIEURBIOLOGIE NR- 1/95

(Translated by Klaus Alt_NRCS)

Implementation in the River Thur in the State (Kanton) Thurgau, river km. 7.17 5 to 11. 0

The river's water carrying capacity had decreased due to siltation and the dams were deteriorating. After 14 years of planning, work started in April 1993.

Goals:

Primary:

• flood protection by improving dams and increasing capacity of river.

Secondary:

• improve biosphere along river (typical — plants, trees, pasture);

• general landscape protection - tourism, local land use factors, ground water effects;

• minimize costs of project.

Measures:

• increase height of dams, using material from ground between dam and river

• lower land between dam and river to 2 to 2.5 m above river bottom widen bottom of channel

• create depressions for water storage during/after floods

• wetlands for wildlife habitat

• reactivate old stream channel

• "appropriate" planting

• prohibition of grazing or fertilization on the dams and in the flooding areas

• management of the State-owned land next to the river (timing of cutting, prohibition of grazing or fertilization)

• widening of river channel on both sides, flat riparian area with breakwaters

• widening on one side, dam improvement (stabilization, plantings), depressions for water storage between dam and river

• old channel reactivation, plantings on silt banks, ecological improvements

The State had to purchase 30 ha (75 acres) of land within project area for this project. Otherwise, State and landowners could not reach compromises on management actions. No detail on what this meant.

Construction Details:

Construction on this 3.8 km section took 18 months, ending in Nov. 1994. The riparian zone flooded frequently, and the resulting erosion repeatedly damaged the newly planted grass cover increased dam size, lowered riparian area, widened channel, added breakwaters, planted cover.

• moved 180,000 m3 of soil;

• increased dam size by 150,000 m3;

• moved 21,000 tons of existing rock formations;

• added 9,000 tons of new rock;

• added 8,000 m3 of gravel, sand and recycled material;

• deposited 30,000 m3 in storage areas.

Costs were kept within approved budget, at Fr 9.82 Million. The State spent Fr 2.4 Million for purchase of land.

Conclusion:

Goals were met, environment was improved. Implementation in the River Thur in the State (Kanton) Thurgau, 3rd part.

• The third part of the implementation built on the lessons from the first two parts.

• The river channel was lowered by one meter which lowered the flooding stage correspondingly, and reduced the flood potential.

• Some river bends were widened.

• Some river banks had been lined with concrete struc

(continued)

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tures. They were broken in several places and only the most exposed banks were protected by breakwaters.

• The stretches between breakwaters were left for nature to landscape herself. Nice, natural banks resulted.

• The right riparian area was lowered to one meter above river bottom.

• The surface was left to natural revegetation, towards the natural climax vegetation.

• An old river channel was reestablished on the left bank, to make a wetland.

• Costs were Fr. 4.65 Million.

• About 56,500 m^3 gravel was taken from the river channel and about 93,000 m^3 riparian soil was taken off.

• The gravel was used for dam augmentation, the soil was moved onto low-lying agricultural areas.

• About 7,500 tons rock was taken from the concrete bank structures that were broken up. This rock plus 6,800 tons of lime were used for the breakwaters.

• The natural banks fit well into the landscape. The scars have healed over.

• As a side effort, 600 meters of a tributary was modified. Its river bottom had run on concrete channel. Where the concrete was removed, the channel was widened and moved towards a natural landscape barrier. The result was a more natural riparian area, with wildlife habitat benefits.

Political support:

The State Office for Water Protection and Water Construction has 2 groups of 5 staff, which work on the rivers between the Rhine and the border to Kanton Thurgau. There are legal differences between the two Kantons in what their staffs can do. The State is sole actor in the channel and riparian areas (incl. dams, channels, and areas up to the high water mark). The staff groups operate largely on their own judgment, within broad guidelines and in dialog with other experts. In K. Thurgau, the State is only part actor, the work is done by the private landowners.

Ecological treatments along the River Thur:

Actions in Kanton Zurich:

Philosophy is to concentrate on soil bioengineering (willow seedlings, fascines, bush plantings; alone or in combination with grass seeding and plantings).

Principles:

• Use only where necessary.

• For grasses, use at least 5 different grass varieties that originated in the Thur valley.

• Leave larger riparian areas to natural revegetation towards the climax vegetation, if this does not endanger the situation during flood periods.

Specific Actions:

• Mow meadows in riparian areas and slopes.

• Seed new plantings.

• Reseed after flood damage.

• Spot treatment on damages (fascines).

• Remove flood debris from newly planted areas.

• Destroy undesirable species in climax vegetation areas.

• Use long term plan; each area is designated by type and checked at least yearly.

Actions in K Thurgau:

• The Kanton does not own land in the riparian area. The local landowners and neighbors have responsibility for mowing of dams and riparian areas; communities for debris removal. Cost share 25-30%. The State is responsible for bank protection, tree planting, maintenance of trails for management.

• Consequently: no central plan, no common criteria; generally higher use intensity of riparian areas. New management methods are difficult to introduce; decisions are difficult to reach.

• K Thurgau is buying up riparian lands and wall lease them for use, but with restrictions, such as a prohibition on fertilization; biases towards extensive use of land.

Conclusion:

Each situation has its advantages and disadvantages.

Site # 6

Location: Thur River, Switzerland

Key Words: River engineering, stream barbs, fish & wildlife habitat

Date: 9/5/95

Description: Second stop on Thur River to observe booms (stream barbs) constructed on outside bend of stream.

Host(s): Christian Goeldi

NOTES

• Our host noted that the approach here was to:

- •Consider "do nothing" as first option and to let system dynamics take their course in achieving acceptable stability.
- •Use soil bioengiering to carry out engineering design functions if measures were needed.
- •Remove riprap toes to allow river to establish regime.

• Very steep storm hydrograph, with stage alarms installed.

• 1500 km^2 drainage area at this point, with low flow of about 15 m^3/sec.

• Land use and land ownership are critical considerations in this area.

• Stream vegetation was said to be important not only as filter of surface water pollutants but also to prevent people from getting onto and damaging the banks.

• Good application of barbs, but some designs could be improved.

• Some barbs are generating strong circulating currents that are eroding the banks below the barbs. Goeldi noted, however, that this is good for King Fisher habitat.

• Inside gravel bar will cause stability problems as the stream tries to regain its cross-sectional flow area (adjacent to campground).

• Connecting a small stream to the Thur River by removing a pipe drop structure is applaudable. It reestablishes the habitat as a continuum from the river up through the stream.

Stream barbs properly installed on outside bend of stream.

Some streambank erosion below installed barbs was noted as good habitat for the King Kisher.

Instream gravel bar will cause the stream to erode the opposite streambank as it regains its cross-sectional flow area.

Site # 7

Location: Thur River, Switzerland

Key Words: River engineering, stream barbs

Date: 9/5/95

Description: Third stop on straight reach of the Thur River where discussion focused on stream corridor width, adjacent land use and planned future work.

Host(s): Christian Goeldi

As the stream adjusts to regain a state of dynamic equalibrium, barbs and riprap will be selectively removed.

NOTES

• Intent is to work on full 22 km. of the Thur in the Canton.

• One objective of this project is to secure as much land as possible in order to permit the river to achieve its own equilibrium condition. As this occurs, Mr. Goeldi noted that some barbs and riprap would be removed. This would depend on the stream geometry.

• Campers and river rafters frequent the area.

• Safety is a great concern and prevents any real-time research.

• Stream barbs installed at about 20 meter frequency.

• Sixty degree barb upstream angle is questionable from a design standpoint. The barb is therefore closer to the bank and does not appear to provide as much refocusing of near-bank flows away from the banks.

Site # 8

Location: Thur River, Switzerland

Key Words: Wetland restoration

Date: 9/5/95

Description: Final stop on a tributary of the Thur River was a small wetland restored for multiple benefits including species diversity and biofiltration.

Host(s): Christian Goeldi

NOTES

• A good example of system treatment and restored wetland functions and values.

• Shallow ditch existed in area prior to wetland restoration.

• Observed diverse species including: Great Blue Heron, amphibians, cattails, and watercress.

A restored wetland.

Host Christian Goeldi (on right), Beat Scheuter, and Robin Sotir discuss merits of restored system.

Site # 9

Location: Chresbachknie, Switzerland

Key Words: Constructed wetland, sediment control, water quality, greenway

Date: 9/5/95

Description: New highway bypass construction project with associated greenway including bike path, wetlands and sediment basin.

Host(s): Christian Goeldi

NOTES

• Land ownership was emphasized; however, work was done on land sold for the highway.

• Original plan called for a trapezoidal channel to convey runoff.

• New design focused on a greenway, including a bike path, and walkway incorporated into the road bridge design, sediment ponds and constructed wetlands.

• First pond was to function as sediment basin for the road construction. Second pond functions as sediment basin and wetland filter for runoff from the watershed.

• Tertiary treatment before downstream release.

• Wetland plants incorporated into pond design were specifically prescribed for the water treatment process.

• Inert fascines were used to stabilize toe of embankments.

• Pre-existing channel was cut about 1.5 meters into aquifer 20 years ago, thereby lowering water table.

• Water table is now rising towards previous levels. Previously excavated channel lowered water table.

• Not much money or effort was spent on documentation or publication of procedures and results.

One of the three ponds functioning as sediment basin and wetland filter for runoff from upland areas.

Plan showing layout of site improvments.

Site # 10

Location: Foxwood, Switzerland

Key Words: Land use, landscape management, erosion control

Date: 9/5/95

Description: Overlooking the Rhine River and steep hillside vineyards. Discussion centered on history of land use changes and resulting landscape structure and function.

Host(s): Otto Weillemann, Samen AG

NOTES

• Area known as Buchberg (hill of the beech).

• Forest erosion problems were said to be caused by not harvesting trees. Our host indicated that the shading reduces vegetative cover, allowing erosion to occur. The development of shade-tolerant grasses and lack of leaf litter were not discussed.

• Vineyards are managed up and down the hill, but little erosion occurs because of grass sod cover. The practice was to keep vineyards clean of grasses prior to the late 1980's.

Sod prevents erosion on extremely steep vineyard slopes.

Area known as Buchberg - "Hill of the Beech." Rhine River in foreground of the photo.

Site # 11

Location: Near Foxwood, Switzerland

Key Words: Mining, land reclamation

Date: 9/5/95

Description: Staged reclamation of large operating gravel pit, to introduce agriculture.

Host(s): Otto Heilleman, Samen AG

Vertical cutslopes at perimeter of site.

Reclaimed area to be used for agricultural production.

NOTES

• Very large operation, said to be one of the largest sources of gravel being shipped for road building and maintenance in the Alps. Large adjacent railroad station.

• High, vertical cutslopes on perimeter of site.

• Landfill, shaping and revegetation of the bottom underway.

• Reclaimed areas intended to again become agricultural production land, with addition of organic materials and proper management.

• OSHA in the United States likely would not permit some of the steep slopes observed.

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Site # 12

Location: Rafz, Switzerland

Key Words: Agriculture, ecological diversity, buffer strip

Date: 9/5/95

Description: Large sod farm owned and operated by, Samen AG Seed Company, an internationally known seed producer and wholesaler. Operation includes practices to introduce species diversity.

Host(s): Otto Weillemann.

Native vegetation used exclusively to establish filter strips along field borders and habitat for beneficial insects.

NOTES

• Red fescue and Kentucky bluegrass are used in combination.

• No polyfiber binder, as used in the US.

• Native plants are used exclusively to create 18-meter wide filter/buffer strips along field borders. They generally consist of a 6-meter strip of grass and herbaceous species, a 6-meter strip of woody native plants in a hedge, and another 6-meter strip of grass and herbaceous species.

• Farmers receive government payment as incentive to plant and maintain buffer strips on adjoining fields.

• Fennel was integrated into these buffer strips because University professors said it controlled an insect (unspecified).

Site # 13

Location: Basel, Switzerland

Key Words: Native plants, species diversity, seed production

Date: 9/5/95

Description: Samen AG Seed Company specializes in certified native plant seed. Supplier of seed for many restoration projects throughout Europe and elsewhere.

Host(s): Otto Hauenstein, owner

Participants prepare to tour Samen Seed Company facilities.

Lath poles set at propsed building height.

NOTES

• Samen AG Seed Company has 3 different locations and elevations for test plots in Switzerland.

• Native plant seed collection done under contract.

• Large quantities of seed are imported from other countries, including the United States.

• Acquiring native seed which is certified relative to source and quality is often challenging.

• Owner, Mr. Otto Hauenstein, has confidence in the state certification of native plants.

• Seed is kept for two or three years to meet changes in market demands.

• Lath poles seen in background of photo are required to be set at proposed building heights to allow public comment before construction. This method was observed at several locations within Switzerland.

Site # 14

Location: Basel, Switzerland

Key Words: Land reclamation, hydroseeding

Date: 9/5/95

Age: 1 yr.

Description: Regrading and hydroseeding on extensive cut slope above operating brick plant.

Host(s): Otto Weillemann and Urs Muller, representative from Begrunungen Hunn AG

NOTES

• Hydroseeded according to Mr. Weillemann's specifications, including asphalt tacking and straw mulching.

• Serious consideration given to seed recommendations relative to microclimate and slope aspect.

• Birdsfoot trefoil used to establish strong root system.

• Mr. Weilleman uses Dr. Schiechtel's table for soil, climate, and erosion considerations in recommending plant mixes.

• Typical agricultural rotations in the area are wheat / potatoes / wheat / sugar beets / corn / barley / grass / grass / grass.

View of operating brick plant from reclaimed slopes.

Recently regraded and hydroseeded slope.

Established plant community approximately one year after regrading and hydro-seeding.

Site # 15

Location: Krauchthal, Switzerland

Key Words: Stream restoration, community involvement

Date: 9/5/95

Age: 2 yrs.

Description: Small, previously channelized stream worked on by community volunteers to reintroduce riparian vegetation for habitat and aesthetic quality.

Host(s): Beat Scheuter and local town council member

Restored stream reach is characterized by slight meander and woody vegetation established from fascines.

NOTES

• Seven hundred meter reach of stream reclaimed by community volunteers.

• Two year-old results appear stable and functioning very well.

• Animal enclosures were introduced to attract muskrat and other species for diversity.

• Straight reach of channel restored with slight sinuous alignment.

• Coir mats and live fascines were installed for erosion control and to establish vegetation.

• Wetland plants were introduced for ecological function and diversity.

• Very smooth bottom (gravelly) allows high water velocities.

Site # 16

Location: Gasthof Zigelgusi, Deiswil, Switzerland

Key Words: Slope stabilization, geogrids

Date: 9/6/95

Age: 5 mos.

Description: Precast concrete geogrid system ("Terrabloc") used to stabilize and revegetate steep highway cut slope.

Host(s): Beatus Scheuter

NOTES

• Cost was 230 Swiss francs/m^2 (includes excavation)

• Terrabloc geogrids by Systec.

• Put together in 4 meter sections, with sod cover.

• Poor soil mixture and heat sink for high summer temperatures observed as potential problems.

• Reestablished vegetation is primarily sourdock (cattle grass).

• Quick fix with poor results expected on long term basis.

NO ILLUSTRATIONS FOR THIS SITE

Site # 17

Location: Mattstetten, Switzerland

Key Words: Revegetation, ecological restoration species diversity, aesthetic quality

Date: 9/6/95

Age: 3 yrs.

Description: Large area within railroad rights-of-way, where seeding and limited plantings of native species were accomplished. Variations in site conditions were used to establish diversity in indigenous flora and fauna.

Host(s): Christopher Dietz

NOTES

• Goal was to establish species diversity and give rail passengers aesthetically pleasing views.

• Largely a revegetation effort, with plantings for diversity, noise attenuation, and aesthetics.

• Low maintenance, slope stabilization, erosion protection, and ecologically focused mitigation were additional goals.

• Identified as a very important public relations project for the railroad; therefore experts who could respond to the project goals were brought in at an early stage of the process.

• Soil bioengineering was not used.

• First site observed where primary goal was to introduce species diversity.

• Previously wooded area that was taken by the RR cut was not intended to be restored to woodland. Varying densities of vegetation with irregular edges and openings were instead prescribed and carried out by designers.

• Extremely dry site with gravelly soils.

• Rough grading produced variations in soil moisture (wet and dry areas); further expanding the species diversity being sought.

• A diversity of insects and animals, relative to slope aspect and roughness, are desired.

• Weedy species are viewed by the ecologists as contributing to species diversity but not easily accepted by the surrounding farmers who are concerned about invasion into their fields.

• Maintenance of vegetation was being done by manual pruning as opposed to the usual spraying program carried out elsewhere.

Restored vegetation reflects the goal of species diversity, including those species considered weeds by local farmers.

Rough finish grading and site preparation produced variations in soil moisture.

Varying densities of vegetaion with irregular edges and openings were prescribed.

Site # 18

Location: Berne, Switzerland

Key Words: Noise abatement, slope stabilization

Date: 9/6/95

Age: 5 yrs.

Description: Extremely unstable cut slopes within transportation corridor. Soil bioengineering and geotechnical systems installed to revegetate and stabilize slopes as well as provide foundation for utility tower.

Host(s): Beatus Scheuter

NOTES

• Systems used from one side of the corridor to the other offer a good comparison. High maintenance, irrigated system on one side versus low maintenance, soil bioengineering system on the other.

• A noise wall (high maintenance, irrigated system), consisting of a vegetated earthen berm on a 2.5:1 slope, appears to be extremely effective.

• Surface tension crack on soil bioengineered side of the corridor and related utility tower stability was of significant geotechnical concern.

• Team consisting of soil bioengineer and geotechnical engineer worked together on design and installation.

• There was confusion regarding responsibility and liability for slope stability — the geotechnical engineer or the soil bioengineer.

• Position of the utility company relative to liability regarding the tower stability was unclear.

• Additional vegetation was installed to compensate for anticipated loss due to harsh site conditions.

• Plants in shaded portions of the site were much more vigorous than elsewhere due to increased moisture and reduced temperatures.

• Felt weed barriers used to retain moisture and otherwise aid plant establishment appeared sporadically successful.

• Response of the installed vegetation was impressive, considering the high levels of pollution from trains and automobiles in the travel corridor.

Conditions were extreme for carrying out successful stabilization and revegatation measures due to the site being located in a major transportation and utility corridor.

Surface tension crack near base of utility tower is subject of significant concern.

High maintenance, irrigated system installed adjacent to highway on opposite side of transportation corridor.

Site # 19

Location: Arisdorf, Switzerland

Key Words: Noise abatement, landscape ecology

Date: 9/6/95

Description: Noise abatement and visual barrier system located adjacent to major divided highway. Barrier is a designed fill paralleling the highway that has a horizontal crest and fills in a small valley that leads into an adjacent village. A secondary road passes through the barrier via a concrete box tunnel.

Host(s): Hans Buser, Landscape Ecologist

NOTES

• The design appears to be effective in providing a desired visual and acoustic barrier between the highway and adjacent community.

• Unsure why this design was built, as opposed to some kind of engineered wall of steel, concrete, etc.

• This was likely a relatively expensive design to implement, although maintenance may be lower in the long term.

• A landscape scale analysis was done in the planning stage of the project.

• Soil bioengineering, in conjunction with geotextiles, was confined to the upper part of the barrier.

• Highway engineers restricted the use of willow, so the design was a compromise. Willow was not used on the highway side of the barrier.

• The amount of willow vegetation established in the geotextile wraparound system was impressive.

• The amount of colonization on the exposed slope was remarkable.

• Response of vegetation varied significantly from the lateral ends of the barrier to the higher parts of the noise wall as it crossed the valley,

Setting for noise abatement and visual barrier system.

System was compromise between highway engineers and ecologists, resulting in limited vegetation (no woody species) on side facing highway.

Side opposite highway was not seeded and shows remarkable colonization of vegetative species.

possibly due to moisture and microclimate differences and proximity to seed source.

• Subsoil with no seeding on the side opposite of the highway resulted in better rooting, more species diversity, lower maintenance, and better water infiltration.

• Looped coir material was used on steep portions of the barrier facing the highway, but was not very effective in terms of catching and germinating seed applied by hydroseeding.

• Where used, the jute apparently was effective in providing medium for seed establishment and erosion control. It was not appropriate for reducing surface tension to improve slope stability. Mr. Buser did not specify jute on the side opposite of the highway. It was obvious that the jute was breaking down but has been effective for erosion control.

• Little apparent reason for remarkably well established grass cover on the steep northern section of the barrier.

• Rocks used in the system were said to be good habitat for lizards.

• Project may attract fauna to the highway, which is not desirable.

• Although grass cover was well established, highway engineers stated concerns about it not being greener in color. This points out the need to educate others in the full range of ecological and other benefits being derived on this and similar projects.

• A valid concern in some cases was a lack of root-holding ability and its effect upon surface stability; however, this concern was apparently not voiced. It was noted that tufted material has been used in India with looped material down, rather than up as used in this project.

• It was suggested that the perception of what is ecologically successful versus just being green needs to be better defined and shared .

Concern over brown color of grass points out need to educate others on the full range of ecological, social and economic benifits being derived by the installed system.

Excellent response from willow cuttings installed in geotextile wraps.

Design appears to be effective in providing desired visual and acoustic barrier.

Site # 20

Location: Birs River at Zwingen (near Basel), Switzerland

Key Words: Stream restoration

Date: 9/6/95

Description: Restoration of salmon habitat through use of soil bioengineering and associated systems installed by local community volunteers.

Host(s): Zeller Urs

NOTES

• The Birs River is considered a priceless spawning tributary for salmon in the Rhine River system. Our host claimed that the project increased this function in the Birs by 200%.

• First year of activity had multiple purposes, while later efforts were geared more to creating fish habitat.

• The project was based upon a long-term, volunteer commitment from local residents and the community.

• Effect of volunteer work on stream mechanics and geomorphology was unknown. No modeling or analyses were performed. Design was based on previous work elsewhere.

• Local politician wrote formal letter absolving himself of responsibility for the work done.

• Previously used rock were reformed into groins for more valuable habitat as well as for erosion control.

• Live fascines with metal banding, as opposed to plastic, was a newly observed method. Apparently the Swiss avoid introducing synthetic polymers into the environment where possible. In this case, they considered metal to be a natural material in the soil and therefore not an introduced nonbiogradeable substance.

• Some of the live fascines seemed to be poorly installed, perhaps reflecting volunteer capabilities.

Birs River is an extremely important tributary and spawning ground for salmon in the Rhine River system.

Metal banding on live fascine bundle was a new invention, not seen elsewhere.

Improvements are the result of volunteer commitment from local residents and the community.

Site # 21

Location: Koeniz, Switzerland

Key Words: Stream restoration

Date: 9/6/95

Age: 4 mo.

Description: Complete realignment and restoration of small stream functions. Reflects detailed design and installation of soil bioengineering and related systems. Adjacent land use, including community cemetery, presented severe design constraints.

Host(s): Beatus Scheuter

NOTES

• Cost and Area Treated: 240,000 Swiss francs

• Project is located in a 10 km^2 drainage area and is 400 to 500 meters in length.

• Channel was previously contained in a culvert.

• Initial design called for a straight rock revetment channel.

• Final design resulted in curved alignment accomplished by recycling revetment rock in a randomly arranged series of transverse groins and longitudinal underwater “side weirs.”

• Design and attention given to the stream did not extend into the floodplain. This was a reflection of the constraints placed on the designer.

• Stream needed to have additional designed sinuosity in the steepest, straightest reach; however, Beat was called into the design process too late to accomplish this.

• Heavy metals were discovered in the removed sediment. Source unknown.

Restored stream was previously contained in a culvert.

The attention to detail and variety of measures used in restoring the stream system was impressive.

Careful placement of rock provided streambank stability.

• The variety of bank protection measures and systems (fascines, step pools, etc.) was impressive.

• Tilting stones back into slope to hold them in place was an innovative solution to the problem of undercutting.

• Detail in making a pond for frogs, as well as the viewing port for fish on a cross bridge was extraordinary.

• Design called for an upstream sediment collector, resulting in ease of maintenance.

• Willows installed in downstream reaches of the project will eventually be shaded out by the larger trees that were planted.

• Large number of ducks inhabiting the project site may cause nutrient imbalance, avian diseases, and high bacteria levels.

• The team was impressed with the rapid response of this project, which appeared very natural in appearance in spite of having been completed four months prior to visit.

Response of live fascines and other vegetation (four months after installation) was excellent.

Beat sharing project results with team members.

Site # 22

Location: Lake Zug, Berne, Switzerland

Key Words: Shoreline protection, beach stabilization

Date: 9/7/95

Age: 6 yrs.

Description: First of two shoreline protection sites in the vicinity of heavy recreation use area on Lake Zug.

Host(s): Ernest Moos

NOTES

• Cost and Area Treated: 300 meters, about 400,000 to 500,000 Swiss francs

• This six-year-old project was considered to be unsuccessful due to continued beach erosion.

• Design engineers are receptive to using nontraditional treatment systems at this heavily used shoreline for aesthetic reasons.

• It was apparent that shoreline stabilization came late in the design or implementation process of this project.

• Modeling was considered too expensive and was therefore not done.

• No ice problems or freeze and thaw conditions exist in this particular area.

• Beat Scheuter noted that the live fascine and brushlayer system could be more effective if placed down lower behind rock buttresses on the mini-peninsula.

• Anticipated design may preempt beach access in some areas.

• Planting at hard points will allow beach access without damaging planted vegetation.

• Team members suggested using randomly placed small rock as a toe support. Soil/rock reinforcement with an outer rock armor layer was preferred.

• NRCS participants provided technical guidelines for computing wind fetch and wave amplitude design.

Portion of shoreline projection and heavy recreation use area.

Coir wrapped rock and floating log breakwater system has been moderately successful in preventing beach erosion.

Site # 23

Location: Lake Zug Naturschutzgebeit, Choller, Switzerland

Key Words: Shoreline protection, beach stabilization, land reclamation

Date: 9/7/95

Age: 10 yrs.

Description: Completely reclaimed and protected shoreline for recreation and nature reserve.

Host(s): Ernest Moos

NOTES

• Cost and Area Treated: 800,000 Swiss francs

• Ten-year-old project was considered to be very successful

• Everything was thumbnailed in without calculations. The design was said to be“ informal.”

> •The federal government being involved in this type of cantonal project brings a better organized engineering process, involving checking and overview.
>
> •Cantonal supervision and checking capability is very limited due to lack of resources. Only where material or extreme local hazard events have been recognized and tackled, (i.e., landslides or flooding), do the normal overview processes expected in the U.S. or U.K. apply.

• Private firms, community, town and state all shared in the project cost. No federal funds were used because it was not deemed of national interest. State department of the environment is responsible for the management of the project. The town is responsible for the maintenance of the project.

• It was suggested that design can occur without numerous design calculations if it is based on experience and observations.

• Use of woven wire fencing has been successful in directing flow of people in this heavy recreation use area.

• Stream delta creates a peninsula that helps protect the cove.

• One way to establish wetland vegetation on an island environment is to install fence.

• Creation of site, sound, and wind barriers with a brush mattress installation was very successful and effective.

• The fact that the project has succeeded without bringing in lots of fill material was not emphasized by the engineer.

Master plan shows portion of Lake Zug shoreline reclaimed for recreation and natural reserve.

Brush mattress installations were successful.

Site # 24

Location: Zugenberg, Switzerland

Key Words: Slope stabilization, reforestation

Date: 9/7/95

Age: 3 yrs

Description: Extensive clear-cut steep mountain slope with surface drainage problems along an incline railroad. Engineered drainage, soil bioengineering, and extensive plantings of native trees, shrubs, grasses, and forbs were installed to stabilize and revegetate slope.

Host(s): Richard Ochsner

NOTES

• Cost and Area Treated: 240,000 Swiss francs, 1600 m^2, 150 Swiss francs/m2, about 2 hectares of treated area

• The minister of forestry cut 240 hectares resulting in landslides that covered the incline railway and threatened the adjacent community. Team was shown old photos revealing critical conditions before work was done.

• Project is situated in a 18 hectare drainage area.

• Many seeps on the lower portion of slope.

• Microclimate was a critical consideration for initial establishment of vegetative plantings and soil bioengineering systems.

• Masonry walls from original construction led Beat to change his design from brushlayering to live staking with willows.

• Old stone wall system discovered along both sides of railway affected installation of live staking, requiring alternate brushmattressing. The discovery of the stone wall should have resulted in a decision that live staking or brushmattressing were not needed there.

• Lateral French drains were designed and installed into a collection system on west facing slope of railway, resulting in excellent response of diverse plant community.

• Lack of plan/drawing made it difficult to appreciate the full extent and function of the 3-year-old French drains.

• Brushlayers were used on one slope in combination with French drain system and perforated 8cm plastic drain pipe.

• Design called for crisis-crossed layout for plantings.

• Grass is clipped to limit competition.

• Yellow plastic survey-type tape was used to wrap the vegetative plantings like a spider web to repel deer, since they were said not to like movement of the tape caused by wind.

• Diverse community of plant species beginning to become established through original plantings as well as natural colonization.

• Team was impressed with the mixture of vegetation prescribed, which ranged from pioneer and establishment species to climax species.

View of incline railway adjacent to project site.

Geotextile material was used to strengthen brushlayer systems initially installed.

Site # 25

Location: Cham, Switzerland

Key Words: Slope stabilization

Date: 9/7/95

Description: Complex geotechnical and soil bioengineering project at large community Sewage Treatment Plant (STP).

Host(s): Beat Scheuter

NOTES

• Very complex geotechnical and soil bioengineering systems used extensively with surface and subsurface drainage to stabilize massive cut slope.

• The extent and details of master planning prior to project implementation were unknown at time of our visit.

• Land ownership was a prime consideration in determining its location.

• Unfortunate that expansion of the STP was carried out at this location, relative to the complexity of planned facilities, the resulting extensive site disturbance, and cost of construction.

• Local community demanded that site disturbance from construction of large sewage treatment plant be “greened up”.

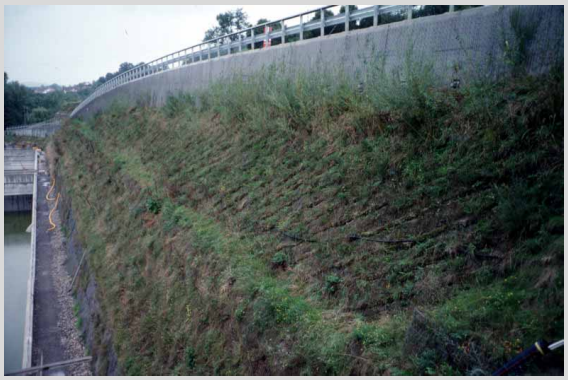
• Sewage treatment company wanted to expand, and was willing to do anything the town wanted.

• Great cost to “green up” with little apparent consideration of long-term results of measures installed.

• Project reflects maximum utilization of a relatively small space. Also brute force engineering, tempered with vegetation.

Extensive surface and sub-surface drainage systems were installed to stabilize the cut slopes.

Project reflects brute force engineering, tempered with vegetation.



Diagonally placed coir strips provide for surface drainage, but support little vegetation.

• Team felt that the vegetative components of the project will likely fail in a few years.

• Willow species are valuable components in the system, providing slope stability, but will not endure over long period of time.

• Lightweight galvanized grills fixed to face of steep cut slope will provide foundation for ivy and other climbing plants. These are intended to screen from view the concrete crest wall, engineered to support the access road.

• Although the diagonal vegetated coir strips will likely provide for surface drainage, they appeared to support only moss.

Expanding view of sewage treatment plant reveals extensive site disturbance and complexity of planned facilities.

Site # 26

Location: Fritz Shar farm, Bernese Oberland, Switzerland

Key Words: Agriculture, farmstead

Date: 9/7/95

Description: A brief glimpse of a working Swiss farmstead.

Host(s): Fritz Shar and friend

NOTES

• Diverse traditional farming operation, with intensive hand labor, but some mechanization.

• Barn is attached to the main farmstead house.

• Small field sizes, long crop rotations.

• Acreage for livestock: 3/hectare maximum.

• Manure is composted partially before application on fields. Both liquid and solid spreading used.

• Cannabis grown under contract for U.S. pharmaceutical firms.

• Quality is a problem, relative to the medicinal requirements. Theft is also a problem.

Very productive vegetable gardens are a mainstay of many Swiss farms and residences.

Our hosts in front of main farmstead residence and portion of attached barn.

Recently harvested Cannabis, grown for U.S. pharmaceutical industry.

Site # 27

Location: Roetler, Switzerland

Key Words: Noise barrier

Date: 9/8/95

Age: 9 yrs

Description: Extensively planted geotextile and soil bioengineered wall constructed to buffer a farmstead from major highway noise.

Host(s): Beatus Scheuter

NOTES

• Cost and Area Treated: 300,000 Swiss francs, 300 meters long and 4-5 meters high

• Department of transportation obtained permission to construct the highway by providing sound barrier for the farmer.

• Bioengineered composite geotextile reinforced soil environmental barrier was constructed following retrospective traffic noise federal legislation regarding maximum noise levels to be imposed by theoretical capacity flows, exceeded at the farmstead.

• The noise was reduced by about half to 9dB.

• Designed by Helgard Zeh, landscape planner/ soil bioengineer, and Worbs Bern, Contractor Kettler Soil AG.

• Geotextile wrapped soil layers with willows and hawthorn brush layers.

• Hawthorn is beginning to dominate over willow.

Established nine-year-old noise barrier adjacent to major Swiss highway.

Geotextile wrapped soil layers were used in combination with brush layers of willow and hawthorn to complete the installed system.

Site # 28

Location: Biehle Lake, Switzerland

Key Words: Shoreline protection

Date: 9/8/95

Description: Islands constructed of fascines (soil bioengineered system) to protect shoreline and marina on a heavily used recreational lake.

Host(s): Beatus Scheuter

NOTES

• Reeds (Phragmites) were said to have died out due to heavy fertilizer and nutrient loads.

• All new houses are now required to have a nutrient management plan, resulting in reduced nitrate levels.

• Islands of reeds were established behind a large cutoff fascine breakwater in about 1m of water.

• Fascines were used to revegetate artificial islands, which float with the waves and successfully dissipate energy.

• Gravel trapped in the center of the fascines keeps base of fascines submerged and anchored to stakes driven into bottom of shallow lake.

• Fascines act as breakwater for the front of the reed establishment area.

Reed island established to dissipate wave energy.

Fascines anchored to stakes driven into lake bottom function as a breakwater.

Site # 29

Location: Gletsch, Switzerland

Key Words: Slope stabilization, streambank stabilization, alpine

Date: 9/8/95

Age: 5 yrs.

Description: Variety of inert and living materials used in severe high alpine conditions to stabilize upland slopes and streambanks in Swiss Alps.

Host(s): Beatus Scheuter

NOTES

• Fragile alpine environment is being severely impacted by heavy grazing.

• Stream culverts and cribs of wood and stone were designed and installed to solve the problem of upslope runoff that was causing downcutting under the access road.

• Other installed materials and measures include jute erosion control fabric, a dry rock wall building rock gabions.

• Prostrate miniature willows were established in sod placed on a large vulnerable slope beside the entry to a large stone culvert/bridge.

• Good results from installed vegetative measures in spite of cold temperatures and short growing seasons; however, results are often defeated by unmanaged grazing.

Fragile alpine slopes and vegetative communities impacted by livestock grazing.

Steep slopes, cold temperatures, snowpack, and short growing season present severe conditions for restoration measures.

Beat discusses restored vegetative community which includes a prostrate minature willow species.

Close-up view of restored vegetative community reveals rich species diversity.

Dry rock wall constructed to stabilize steep slopes.

Site # 30

Location: Furks-Bergstrecke, Switzerland

Key Words: Slope stabilization, alpine

Date: 9/9/95

Description: Variety of inert and living materials used to stabilize steep alpine slopes adjacent to restored Dampfbahn (Steam Train) railroad in Swiss Alps.

Host(s): Beatus Scheuter

NOTES

• Steam/cog railway.

• Engines reclaimed from Vietnam and restored through private restoration group.

• Steep cut slopes require concrete gabions constructed of railroad salvage materials.

• Various crib and gabion cut slope support retaining walls.

• Many geotechnical problems in tunnels threaten viability of the rail line, as does the quality of the maintenance, which is limited by funding.

• Very difficult to restore tundra-like vegetation due to high altitudes, cold temperatures, and poor soil conditions.

Beginning point of restored stream/cog railway, and one of the restored steam engines.

Section of railway includes center rail for cog wheel.

Looking back on the railway revealed steep, highly erosive slopes and severe alpine conditions.

Unique timber bridge design near railway.

Tunnel and section of railway yet to be restored.

Participants have an opportunity to thank Beatus Scheufer and his wife, Eva (front center), before departing Switzerland for the second leg of the trip into Austria.

Site # 31

Location: Alberg (near Innsbruck), Austria

Key Words: Slope stabilization, stabilization, soil bioengineering, surface drainage, geotechnical

Date: 9/11/95

Description: Massive highway cut near tunnel entrance required complex geotechnical stabilization, drainage, and soil bioengineering systems.

Host(s): Dr. Hugo Meinhard Schiechtl

View of the tunnel entrance and portion of complex site conditions.

Concrete cribbing was used on severely steep slopes and near tunnel entries.

Rock-lined waterway used to control surface runoff. Adjacent willows installed as live fascines to provide slope stability.

NOTES

• Tunnels (twin reinforced concrete tubes or cylindrical, horizontal shafts) were preferred for noise abatement for villages in the adjacent valley, due to lower required maintenance, and reduced need for stabilization of exposed slopes. Also provided lower landslide and avalanche hazard for the highway.

• Granitic gneiss on one side, Triassic limestone on other, with intervening highly fractured rock.

• South facing slope presented dry site conditions which prompted use of drought-tolerant grasses in a prescribed seed mix.

• All slopes eroded severely during construction.

• Hydroseeding with straw mulch was used for erosion control on critical areas.

• The establishment of “natural” islands of vegetation, which are considered to be highly desirable from an ecological standpoint, were special features in the project. Dr. Schiechtel determined their placement during construction.

• Drainage systems comprised of vertical gravel strips, 1 to 2 m deep, were used to direct water

safely off site. Deep caisson drains with pumped and gravity drainage were also used.

• Live fascines were used along surface channels for stability on very steep gradients.

• Tunnel entry structures consist of concrete crib or multicomponent terrace structures, planted to shrubs. Lack of willows was conspicuous.

• Apple trees were planted on platforms over crowns of buried highway tunnels.

Dr. Schiechtel determined placement of islands of vegetation, a desired future condition from an ecological diversity perspective.

Site # 32

Location: NordiTirolr (near Innsbruck), Austria

Key Words: River engineering, diversion, vegetated retaining wall

Date: 9/11/95

Description: River diversion with central groins and vegetated boulder retaining walls.

Host(s): Dr. Hugo Meinhard Schiechtl

NOTES

• River was redirected, using spoil from highway construction.

• Groins were placed on inside curves.

• Large boulder retaining walls with integral willow brushlayers were also incorporated along the streambank.

Relocated river; note rock groins placed in new stream channel.

Vegetated rock wall installed to stabilize steep slope on opposite side of river.

Site # 33

Location: Landek, Austria

Key Words: Slope stabilization, soil bioengineering

Date: 9/11/95

Description: Very steep cutslope overlooking major highway. Geotechnical engineering and soil bioengineering used for stabilization and protection of adjacent community and park.

Host(s): Dr. Hugo Meinhard Schiechtl

NOTES

• Steep cut slope was benched in order to preserve a narrow, 15-meter wide, strip of land for community park area.

• Community of Landek lies along river in valley below project site.

• Portions of the area are fenced for horses.

• Earth material is very unstable gravel and rock.

• Large concrete anchors with post-tensioned tiebacks were used to stabilize very steep slope (75 m high)

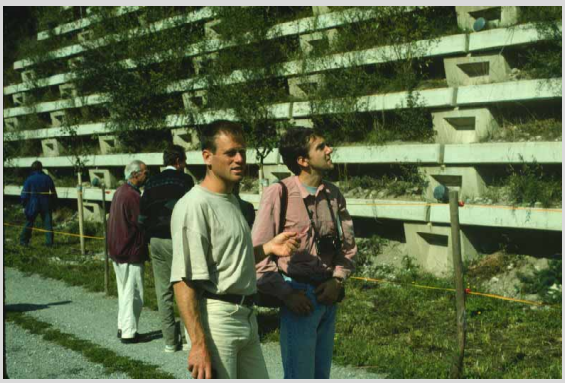
• Willows have become established between the concrete anchors, where ground water seepage occurs.

• Vegetative cover established elsewhere on site, using native seed mixture.

• Contract made with neighboring residents to care for the small apple orchard planted on the project site.

Portion of project site showing steep cut slope, benched park area, and nearby community of Landek.

Concrete cribbing used to stabilize steep slope.



Marco Subik (left) and Joze Papez from Slovenia look more closely at the details of concrete anchors and tie back components of the geotechnical system.

Small apple orchard planted on the project site will be maintained and utilized by neighboring residents.

Site # 34

Location: Tirolr Wasserkraft, Austria

Key Words: Slope stabilization, reclamation

Date: 9/11/95

Age: 31 yrs.

Description: Reclamation of high alpine slopes disturbed by construction of large rock fill dam.

Host(s): Dr. Hugo Meinhard Schiechtl

Construction of this large, rock filled dam caused extensive denuding of surrounding alpine slopes.

NOTES

• Excavation for borrow materials and access in contracting a large rock fill dam resulted in extensive denuding of surrounding alpine slopes.

• Dam is 150 meters in height, contains 8 million m^3 of fill, and took 3 years to build.

• Elevation of 2700 meters makes this one of the highest dams in Europe.

• Establishing vegetation on the denuded slopes was difficult due to soil disturbance and high altitude. Dr. Schiechtel experimented with native species and developed a seed mix that became established.

• Area is grazed but shows little damage because of the success of the legumes in the mix which have deep roots. Cattle apparently avoid these mature legumes because of toxicity.

Restored alpine slopes show little damage from heavy grazing due to deep-rooted legumes which livestock avoid because of toxicity.

Site # 35

Location: Austria

Key Words: Wetland

Date: 9/11/95

Description: Turbid lake and wetland associated with hydroelectric power generation.

Host(s): Dr. Hugo Meinhard Schiechtl

Widely fluctuating water levels cause rapid changes in this high mountain scene.

NOTES

• Site of lake and associated wetland provides water storage for electrical generation.

• Intake leads long distance through mountains taking water for power generating purposes into the adjacent valley.

• Rapid and widely fluctuating water levels have caused erosion and a challenge for habitat protection and enhancement.

Site # 36

Location: Austria

Key Words: Slope stabilization, streambank protection

Date: 9/11/95

Age: 47 yrs.

Description: Soil bioengineering and engineering measures used to stabilize large landslide area and streambank along outlet channel associated with hydroelectric generating facilities.

Host(s): Dr. Hugo Meinhard Schiechtl

Natural colonization on stabilized landslide area above outlet channel has resulted in mixed conifer/hardwood forest.

Hand placed rock reventment and associated joint plantings have successfully stabilized outlet channel and established riparian vegetation.

NOTES

• Landslide area stabilized and revegetated .

• Willow and alder brushlayer system used to stabilize and initially revegetate landslide area.

• Subsequent natural colonization on landslide area has resulted in mixed conifer/hardwood forest where coniferous species are dominant.

• Outlet channel protected by hand-placed rock revetment with associated joint plantings of shrubs.

• Hydroelectric generating station is situated inside the mountain with the inlet located at the previously described turbid lake/wetland site (site #35).

Site # 37

Location: Nasses Tal/Vols Community, Austria

Key Words: Slope stabilization, streambank protection

Date: 9/12/95

Age: 4 yrs.

Description: Streambank and catchment basin of flood retarding dam protected with native seed mix and plantings.

Host(s): Dr. Hugo Meinhard Schiechtl

NOTES

• The flood retarding structure is part of a federal project and provides flood protection for community.

• Concrete structure has 1,000 year storm frequency design for storm water retention purposes.

• Largest grade control structure of several similar structures built upstream in step-wise fashion with drainage areas ranging from 1 to 200 sq. km.

• Structure has never flowed.

• Structure is “dry” and has no permanent pool of water. Normal stream flow is through the structure via a pipe.

• SAF-type (St. Anthony Falls Hydraulics Laboratory design) energy dissipating blocks are equally spaced along downstream chute, with intervening areas in grass sod.

• Grass sod between energy dissipating blocks would likely erode quickly due to turbulence around blocks, if structure ever flowed.

• Placing the blocks in the outlet part of the chute has been successful in the United States. It provides a stable outlet, with only a small energy-dissipating pool needed at the chute outlet.

Largest of several grade control structures constructed on this stream to provide flood protection.

Streambank and catchment basin have been protected with native seedmix and plantings.

Grass sod between dissipating blocks will likely erode if spillway were to flow.

Colleagues Dr. Schiehtl and Robbin Sotir confer on some finer points of design.

Site # 38

Location: Birgitz at Axams, Austria

Key Words: River engineering, channelization

Date: 9/12/95

Description: Joint and associated plantings used to visually soften a concrete lined outlet channel below a water supply dam.

Host(s): Dr. Hugo Meinhard Schiechtl

Hand placed rock revetment and associated joint plantings have been used to stabilize this high gradient stream.

NOTES

• Site is located downstream of Site #37.

• Rocks were hand-placed and cemented into bottom and banks of 5m-wide channel.

• Joint plantings were established between the rocks.

Site # 39

Location: Axams, Austria

Key Words: Slope stabilization, reforestation

Date: 9/12/95

Description: Soil bioengineering systems used successfully to halt severe gully erosion and to reforest denuded area of watershed in National forest.

Host(s): Dr. Hugo Meinhard Schiechtl

NOTES

• Large ravine (200m+ wide, 30m+ deep) resulted from erosion and avalanche/debris flows caused by destruction of forest associated with severe hailstorms in 1809 and 1908. One meter of hail accumulated and was observed still on the ground three days after the last storm in 1908.

• Highly erodible soil materials consist of silicate moraine with a high percentage of fines, which slump easily when saturated.

• Experiment was carried out to attempt to stabilize the upper part of the landslide area using predominately soil bioengineering systems.

• Edges of the steep scarps were smoothed by hand with hand tools.

• Brushlayering, seeded legumes, and rooted stock provided good erosion control in a 12-hectare, upper part of the ravine.

•All materials for soil bioengineering and associated systems were carried in, since today's road access did not exist at that time.

• Lower part of the landslide area was left to observe if and how nature would repair the scar.

• Initial erosion events were so severe that ensuing natural or geologic erosion prevented any colonization by local vegetation.

• Maintenance is not being performed due to lack of available funds.

• Grading with power equipment would have provided better vegetative establishment, according to Dr. Schiehtl.

• Would have been more effective to seed, spread straw mulch, and install soil bioengineering practices only in the most critical areas.

Large ravine caused by avalanche/debrise flows, offered an experimental site for utilizing soil bioengineering systems for stabilization and reforestation.

Approximately twelve hectares in the upper part of the ravine was treated with soil bioengineering and associated practices.

Site # 40

Location: Axamerlizum, Austria

Key Words: Slope protection, revegetation

Date: 9/12/95

Description: Vegetative seeding and plantings to protect alpine and subalpine slopes from impacts of skiing and avalanches.

Host(s): Dr. Hugo Meinhard Schiechtl

Ski slopes are stable and appear well vegetated in spite of grazing and winter use.

NOTES

• Most slope damages are caused by grazing.

• All slopes are grazed but are in good hydrologic condition .

• Prior to grazing, the upper mountain slopes are subjected to two hay cuttings per year, while lower valley slopes receive three cuttings for hay.

Site # 41

Location: Brennen Autobahn, Austria

Key Words: Slope stabilization, reforestation

Date: 9/12/95

Age: 31 yrs.

Description: Soil bioengineering and associated engineering systems used successfully to stabilize and reforest extensive landslide area.

Host(s): Dr. Hugo Meinhard Schiechtl

NOTES

• Project site is located near the Brenner Autobahn and highest bridge in the world (200m).

• Brushlayering systems and associated engineering structures were used to stabilize toe of slopes.

• Wooden posts were installed in a 2m x 2m grid, forming prefabricated lattices, which were backfilled and planted.

• Initially installed willows have been succeeded by pines.

Photo showing denuded cut slopes from construction of Brenner Autobahn in the 1960's which resulted in extensive landslide areas.

Stabilized and reforested slopes of today seen from approximately same view point as preceeding photo.

Close up view shows initially planted willows and other species giving way to a succession of pines.

Site #42

Location: Innsbruck, Austria

Key Words: Streambank protection

Date: 9/12/95

Age: 30 yrs.

Description: Bedrock slabs hand placed as revetment with joint plantings used successfully to protect streambank and establish riparian system.

Host(s): Dr. Hugo Meinhard Schiechtl

NOTES

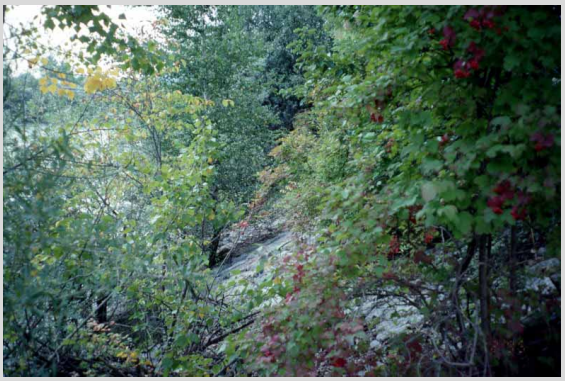
• Cost of rock and joint planting system was half of original riprap design because smaller rock could be used.

• System was installed on 2 1/2:1 slope.

• Austrian hydraulics laboratory is conducting research on the effects of rock size and woody vegetation on water elevation, roughness, stability, and erosion criteria. Specific installation methods are taken into account.

• Earthtone colored metal wall on opposite shore of river reflects desire to blend new structures into landscape.

Rock revestment and joint planting system are successful in protecting streambank.



Community of riparian vegetation is becoming well established from joint plantings.

Earthtone color of wall on opposite side of stream was used to blend structure into its surroundings.

Site # 43

Location: Innsbruck, Austria

Key Words: Streambank protection

Date: 9/12/95

Age: 30 yrs.

Description: Rock groins with mature trees growing from them to trap sediment & protect public beaches along large river.

Host(s): Dr. Hugo Meinhard Schiechtl

Combination of rock groin and mature stand of trees have withstood frequent storm events and been successful in trapping sediment to rebuild public beaches.

NOTES

• Excellent example of interdependency of functions between engineering structure (groin) and associated mature stand of trees.

• River was originally moved to allow harbor construction.

• Popular public recreation beaches and boat launch, are now protected by rock groin and mature trees.

• Trapped sediment provides source of construction fill material.

Public beach and popular boat launch area restored and protected by installed system.

Site # 44

Location: Pitzbach, Sud Tirol, Italy

Key Words: Streambank protection

Date: 9/13/95

Age: 4 yrs.

Description: Concrete grade control structures and soil bioengineering system of live cribwall/ brushlayer used to protect engineered channel.

Host(s): Dr. Alexander Pramstaller, Director of Bioengineering, Sud Tirol Provincial Government

NOTES

• Grade control structures were built first. Bank protection not installed as part of the overall hydraulic design.

• Design tractive force was said to be 300 kilo-Newtons/m^2.

• Live cribwalls and brushlayering installed to protect channel banks.

• Very good stand of willows established as result of the soil bioengineering systems.

• Brushlayers were pushed into the undisturbed streambed behind the crib walls.

• Jute rope used to hold brushlayered willows in place.

• Torrent flow has not occurred since systems were installed four years ago.

• Participants believe rock weirs or other "less-than-concrete" measures would have offered acceptable alternatives with less impact upon the environment than the heavily engineered system observed.

Grade control structures were constructed first, with no provisions for bank protection.

Details of live cribwall and brushlayer systems are still visible.

Soil bioengineering systems have responded successfully and are quickly restoring riparian vegetation.

Site # 45

Location: Wellsburg, Sud Tirol, Italy

Key Words: Reclamation, reforestation

Date: 9/13/95

Age: 5 yrs.

Description: Soil bioengineering and seeding of woody species used to vegetate and reclaim damaged floodplain.

Host(s): Dr. Alexander Pramstaller

Project site shows excellent response of seeding alder and installing live willow stakes to accelerate natural colonization in this torrent stream corridor.

NOTES

• Prior to 1966, the stream was channelized and straightened to reclaim farm land.

• The channel and adjacent floodplain were destroyed during a 1966 flood torrent.

• The resulting channel was subsequently reestablished in its previously straightened form with grade control structures and floodplain and toe plantings.

• Hosts emphasized that the stream corridor was stable and that the slopes would be stabilized through natural colonization, which appears to be happening at a rapid rate.

• Excellent response from alder seeding and live willow stakes used to accelerate natural colonization.

Site # 46

Location: Sud Tirol, Italy

Key Words: River engineering, slope stabilization

Date: 9/13/95

Age: 3 yrs.

Description: Soil bioengineering used to successfully stabilize and revegetate slopes disturbed by construction of large sediment basin located below concrete grade control structures.

Host(s): Dr. Alexander Pramstaller

Brush mattress and live stake systems have responded extremely well to stabilize the slopes adjacent to this large concrete grade control structure.

NOTES

• Project site is located 1100 meters above sea level.

• Monolithic concrete grade control structures are ugly and incompatible with the extreme success in establishing vegetation.

• Brushmattress and live stake systems were used to stabilize banks adjacent to the catchment basin.

• Wetland plants have begun to colonize the overflow sediment pool area.

• Maintenance plans call for cutting back all the woody vegetation every 6 years in order to maintain a flexible dense stand. Ten centimeter diameter is maximum stem size allowed.

• Said to be very good site for migrating shore birds.

Site # 47

Location: Whalen, Sud Tirol, Italy

Key Words: Slope stabilization, reforestation

Date: 9/13/95

Age: 2 yrs.

Description: Conventional cribwall system and plantings used to stabilize and reforest extremely steep eroded slopes.

Host(s): Dr. Alexander Pramstaller and Dr. Karner

Articulated machinery was used to stabilze these extremely steep, unstable slopes.

Two-year-old cribwalls and live fascines are allowing the slopes to stabilize and vegetation to colonize.

NOTES

• A thirty-year old landslide area was successfully stabilized and revegetated 2 years ago.

• Cribwall and associated live fascine systems were installed on severely steep and eroded slopes in forested setting.

• Cribwalls constructed from 20 cm diameter logs, approximately 30 meters long by 1.5 meters high.

• Very comprehensive interceptor drain installed above project site and directed to another location.

• Five woody species, including alder, willow, & privet were planted above and adjacent to cribwalls.

• Plantings were installed in catch basins to utilize runoff.

• Slopes were hydroseeded with seed mix, paper mulch (no long straw), manure for fertilizer, and sea weed.

• Construction implemented with Menzi Muck machines, which employ a fully articulated wheel, and claw backhoe. They can scale very steep precarious slopes, which exist at this project site.

Site # 48

Location: Pfanhorngraben, Rio Corno Fana, S¸d Tirol, Italy

Key Words: Slope stabilization

Date: 9/13/95

Description: Land management and natural colonization used to after initial seeding to stabilize and revegetate large landslide area; thereby, saving nearby village. Landslide stabilization

Host(s): Vice Major and Burgermeister Adolf Reiner, Dr. Alexander Pramstaller

Discontinued grazing and seeding of native grasses and forbs have allowed these steep mountain slopes to stabilize.

NOTES

• Hosts described project as being equivalent to a federally-sponsored watershed restoration project.

• Several vertical meters of soil lost to erosion over 100 years. Mostly natural but exacerbated by the cattle.

• Beginning in 1976, farmers were compensated for fencing cattle out of the area to prevent grazing.

• Seed was collected locally and propagated in Colorado to enhance seedling survival.

• Damaged site was then revegetated with this mix of native grass and forb species.

• The area began to stabilize four years after grazing stopped and seeding was completed.

• Mayor praised all the people from Italy and Austria for “saving the village “ from the danger of landslides.